METHOD FOR DETERMINING A BOOST PRESSURE SETPOINT IN AN INTERNAL COMBUSTION ENGINE WITH AN EXHAUST GAS TURBOCHARGER

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CLAIM FOR PRIORITY

This application claims priority to International Application No. 10235013.2 which was filed in the German language on July 31, 2002, which is hereby incorporated by reference.

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TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method for determining a boost pressure setpoint in an internal combustion engine, and in particular, an internal combustion engine

15 with an exhaust gas turbocharger.

BACKGROUND OF THE INVENTION

In combustion engines with exhaust gas turbochargers and wastegate, the boost pressure is controlled through the

20 bypass in the exhaust gas duct being opened or closed to varying degrees. The exhaust gas mass flow through the turbine, and hence the turbine power output, varies depending on the position of the wastegate. Depending on the varying turbine power output there is a change in the

25 compressor power output and hence the boost pressure.

SUMMARY OF THE INVENTION

The present invention relates to a method for determining a boost pressure setpoint in an internal combustion en-

30 gine, and in particular, an internal combustion engine with an exhaust gas turbocharger which has a bypass line running parallel to the turbine in the exhaust gas duct, the bypass line having a wastegate which is set via a pneumatically operated actuator.

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The invention also relates to types of internal combustion engines in which the pressure actuator for the wastegate is controlled pneumatically by means of air

from the compressor. As a result of this control of the pressure actuator, a situation can arise in which there is not sufficient boost pressure present to control the wastegate. In this case, the boost pressure is no longer

5   sufficient to open the wastegate, with the result that the power output from the compressor cannot be reduced.

The invention provides a method for controlling the boost pressure, particularly to provide a boost pressure set-

10   point, in an internal combustion engine in order to enable reliable and stable control of the boost pressure.

In one embodiment according to the invention, the setpoint for the boost pressure is limited to a minimum

15   value when the wastegate is deactivated. According to the invention, the minimum value is made up of the sum of the environmental pressure and one or more pressure constants. In the invention, the control of the internal combustion engine is limited to the extent that a minimum

20   setpoint for the boost pressure is determined. The minimum value depends on the environmental pressure, the setpoint for the boost pressure not being less than the environmental pressure. The further pressure constants which are taken into account for determining the minimum

25   pressure are dependent on the actual design of the exhaust gas turbocharger, more particularly of the actuator for the wastegate. The invention maintains the boost pressure at a minimum pressure which provides a certain basic power for the system. The basic power ensures that

30   the wastegate is in a closed state such that a sufficiently large pressure is built up in front of the turbine wheel so that the turbine power output which is then delivered is great enough to produce an increase in pressure in the compressor which is used mainly to boost the

35   internal combustion engine but also acts in turn as control pressure for the actuator.

Another embodiment of the invention determines the basic boost pressure which is produced even when the wastegate is actuated via, for example, an electrical or hydraulic wastegate actuator or a pressure actuator which is open in the pressureless state. In these cases, an increase in pressure will generally arise via the wastegate, leading to an undesirable boost pressure (basic boost pressure). This increase in pressure is explained also by the throttle effect of the open wastegate.

In a preferred embodiment of the invention, a speed-dependent basic value is added to the environmental pressure. The speed-dependent basic value is preferably generated by a characteristic curve recorded for a reference system.

An additional pressure constant is preferably determined with the throttle valve open and the wastegate closed, the additional pressure constant being added to the value for the environmental pressure and the basic value. The additional pressure constant ensures that the setpoint does not drop so far that no further control can be effected.

In a preferred embodiment of the invention, the additional pressure constant is corrected adaptively as a function of the measured boost pressure. The adaptive correction of the additional pressure constant ensures that the difference between boost pressure actual value and boost pressure setpoint does not diverge as a result of a limitation over time.

A diaphragm box which is controlled by overpressure and underpressure and which is mechanically linked to the wastegate is preferably used as an actuator for the wastegate. Pressure can be applied to different sides of a diaphragm box of this type, with the result that the movement of the diaphragm is converted into the setting

of the wastegate. The pressure box is preferably preten-
sioned toward the closed wastegate position.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Exemplary embodiments of the invention are explained in
more detail below with reference to the drawings, in
which:

Fig. 1   shows a schematic view of an internal combustion
10   engine with exhaust gas turbocharger.

Fig. 2   shows a schematic view of a wastegate with pres-
sure diaphragm box.

15 Fig. 3   shows the invention as a block diagram.

Fig. 4   shows a schematic view of a switching valve.

DETAILED DESCRIPTION OF THE INVENTION

20 Fig. 1 shows a schematic view of an internal combustion
engine 10. At the beginning of the intake duct the incom-
ing air is filtered (air filter 12) and can be measured
via an air mass sensor 14. A turbocharger compressor 16
is placed downstream in the intake duct, followed by a
25 boost air cooler 18 and optionally by a second air mass
sensor 20. A reflow channel 22 is provided parallel to
the compressor 16. The reflow channel 22 is varied in
terms of its throughflow rate via a reflow flap which may
also be implemented as a reflow valve.

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Located downstream from the second air mass sensor 20 is
a throttle valve 22 which controls the air mass entering
the internal combustion engine 10. The second air mass
sensor 20 also is merely optional. A proportion of ex-
35 haust gas can be mixed with the compressed air introduced
into the internal combustion engine via an exhaust gas
recirculation unit 26. The exhaust gas proportion is de-

pendent on the position of an exhaust gas recirculation
valve 28.

An exhaust gas turbine 32 is provided in the exhaust gas
5 duct 30. It is understood that the exhaust gas turbine 32
is mechanically linked to the compressor 16, wherein the
power extracted from the exhaust gases is converted with
mechanical losses into a compressor power output 16. An
additional secondary air inlet 34 can be provided up-
10 stream of the turbine 32.

Provided in the exhaust gas duct 30 and running parallel
to the turbine 32 is a bypass line 36, through which
parts of the exhaust gases or mixture of exhaust gases
15 and secondary air can be directed past the turbine 32.
The amount of air directed past is determined by a
wastegate 38. If the wastegate 38 is closed, this leads
to a maximum exhaust gas flow through the turbine 32,
which then leads to a maximum compression of the fresh
20 air in the intake duct. The boost pressure is increased
as a result. If, on the other hand, the wastegate 38 is
opened to the maximum, as many exhaust gases as possible
flow through the bypass channel 36, whereupon the turbine
power taken up by the turbine 32 drops. In parallel with
25 this there is a decrease in the power delivered by the
compressor 16 and consequently in the boost pressure.

Fig. 2 shows the actuation of the wastegate 38 in sche-
matic form. The wastegate 38 possesses a wastegate flap
30 40 which covers an inlet opening 42. Toward that end, the
flap 40 is mounted about a swiveling axis 44.

The varying distance between the throttle flap 40 and the
opening 42 produces a reduced throughflow area in terms
35 of flow rate, with the result that a varyingly large pro-
portion of the exhaust gases flows through the bypass
line 36.

The wastegate flap 40 is mechanically linked to a dia-
phragm box 46. The diaphragm box 46 has two mutually
separate chambers 48 and 50 to which pressure is applied
via the lines 52 and 54. Additionally provided in the
5   chamber 48 is a spring 56 which is in contact with a dia-
phragm 58 separating the chambers 48 and 50. The dia-
phragm 58 is linked to the wastegate flap 40 on the side
facing the chamber 50 via a push rod 60. In response to
an actuation of the push rod 60 the retainer arm of the
10   wastegate flap 40 swivels about the swiveling axis 44.

In the position in which pressure is not applied, the
diaphragm 58 is pretensioned by the spring 56 such that
the spring resistance and the power of the exhaust gases
15   flowing through the opening 42 act upon the throttle
valve 40. The wastegate position results from the equi-
librium of forces arising from spring resistance 56 and
exhaust gas pressure force.

20   If a pressure difference is now applied to the two cham-
bers, the pressure force exerted on the wastegate flap 40
increases or reduces, leading to a change in the position
of the throttle valve. Pressure is applied to the cham-
bers of the diaphragm box for example by means of timing
25   valves which are controlled by means of pulse width modu-
lation. The timing valves can be designed such that they
switch back and forth between a high pressure value, for
example the boost pressure, and a low pressure value, for
example the environmental pressure. In an alternative em-
30   bodiment it is also conceivable that operation switches
back and forth between a low pressure value, for example
lower than the environmental pressure, and the environ-
mental pressure or a higher pressure value. Thanks to the
pulse width modulation, virtually any pressure value be-
35   tween the low and the high pressure value can be applied
to each chamber.

Fig. 3 shows the execution sequence of the method accord-
ing to the invention. A value of a basic boost pressure
64 is added to a measured value of the environmental
pressure 62. The basic value is determined with the aid
5   of a reference system and is dependent on the speed 66.
The sum of environmental pressure and basic value leads
to a minimum value 68 for the boost pressure. An addi-
tional pressure constant 70 is added to the sum of the
values 62 and 64. The additional pressure constant 70 is
10   determined iteratively, so that in the illustrated nth
step of the method the additional pressure constant from
the (n-1)th iteration step is added.

The minimum boost pressure value 68 ensures that when the
15   timing valves are used there is a sufficient pressure
difference between boost pressure and environmental pres-
sure to ensure that the wastegate flap can be controlled.

In order to determine the additional pressure constant,
20   the sum of environmental pressure and basic value is re-
duced by the current boost pressure 72. The additional
pressure constant 74 for the nth step is formed from the
standard deviation formed in this way as a function of
the speed 66. For this purpose the pressure constants are
25   stored in a characteristic map 76.

The additional pressure constant 74 is determined in the
case where both the throttle flap is open and there is
control of the timing valves. This condition is specified
30   by the pressure quotient 78 at the throttle valve. The
condition for the open throttle valve results in this
case from the fact that the pressure quotient at the
throttle valve is greater than a predetermined constant.
By suitable redefinition of the pressure quotient it is
35   of course possible that this condition can also be formu-
lated as a comparison to determine whether the pressure
ratio is less.

The control of the timing valves is determined in that their control signal 82 is compared with a constant 84. The additional pressure constant 74 is calculated in the case where the throttle valve is open and the actuator

5 for the wastegate is controlled via the control valves. To this end, both conditions are applied to a switch 86 via a logical AND operation. If a signal is present at the center input of the switch 88, the control difference is forwarded to the characteristic map 76. If not, the

10 determination of the additional pressure constant is omitted.

Fig. 4 shows an example of a timing valve 90 which can be used to apply different pressures to the chambers 48 and

15 50. In the position shown in Fig. 4, the output line 92 of the timing valve 90, which operates according to the principle of a switching valve with two inputs and one output, is linked to its input line 94. In the second setting, the input line 96 is linked to the output line

20 92. If different pressures are now applied to the two input lines 94 and 96, any intermediate value can be generated at the output line 92 by means of appropriate switching back and forth between the first and the second position.